RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.: **437-8540**

SRP Section: **08.01 – Electric Power - Introduction**

Application Section: **8.01**

Date of RAI Issue: **03/08/2016**

Question No. 08.01-15

In RAI 8166, Question 08.01-2, dated August 31, 2015, the staff stated that DCD section 8.2.1 indicates that the APR1400 is designed to meet GDC 2, 4, 5, 17, and 18, however Table 8.1-2 indicated that GDC 5 is not applicable to the APR1400 design. Therefore, the staff asked the applicant to clarify the inconsistency between DCD section 8.2.1 and Table 8.1-2. In response to RAI 8166, Question 08.01-2, dated November 17, 2015, ADAMS Accession ML15321A290, the applicant stated in part that the requirements of GDC 5 pertain to the sharing of SSCs between units and since the APR1400 design is considered as a single unit with no shared SSCs, then the design is considered to meet the GDC 5 requirements. The applicant also revised Table 8.1-2 to indicated applicability of GDC 5 to sections 8.2, 8.3.1, and 8.3.2. The staff reviewed the applicant's response and noted that the addition of GDC 5 to Table 8.1-2 is not consistent with the response which indicates that the APR1400 design is a 1 unit plant and that GDC 5 applies to the sharing of SSCs between units. Therefore, the staff requests removal of the GDC 5 reference in sections 8.2.1, 8.1.3.3, and Table 8.1-2 for consistency with the response and the applicability of GDC 5 to the APR1400 design.

Response

Since the APR1400 is a single unit plant with no shared systems, KHNP will revise the relevant subsections for consistency of the DCD to consider GDC 5 as not applicable rather than applicable and meeting the criteria.

For the same reason, reference to RG 1.81 will also be removed from the relevant subsections.

Impact on DCD

DCD Tier 2, Subsections 8.1.3.3, 8.2.1, 8.2.2.1, 8.3.1.2, 8.3.2.2, and Table 8.1-2 will be revised as shown in the Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

i. The non-Class 1E AAC source is provided to help mitigate the effects of station blackout (SBO) conditions in accordance with NRC RG 1.155. In addition, the AAC source is designed to supply ac power to the non-Class 1E permanent non-safety (PNS) 4.16 kV buses during a LOOP.

j. Non-Class 1E electrical equipment is designed to preclude adverse effects on Class 1E electrical equipment due to its failure during normal, accident, or post-accident modes of plant operation.

8.1.3.3 General Design Criteria, NRC Regulatory Guides, Branch Technical Positions, Generic Letters, and Industry Standards

The electric power system is designed to meet the following requirements of General Design Criteria (GDC), Regulatory Guides (RGs), Branch Technical Positions (BTPs), Generic Letters (GLs), and industry standards. Conformance with RGs and BTPs for electric power systems is addressed in Table 8.1-2 and Section 1.9.

General Design Criteria

- GDC 1, “Quality Standards and Records”
- GDC 2, “Design Bases for Protection Against Natural Phenomena”
- GDC 4, “Environmental and Dynamic Effects Design Bases”
- ~~GDC 5, “Sharing of Structures, Systems, and Components”~~
  Delete
- GDC 17, “Electric Power Systems”
- GDC 18, “Inspection and Testing of Electric Power Systems”
- GDC 33, “Reactor Coolant Makeup”
- GDC 34, “Residual Heat Removal”

- NRC RG 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems," Rev. 1, February 2010.

- NRC RG 1.53, "Application of the Single-Failure Criterion to Safety Systems," Rev. 2, November 2003.

- NRC RG 1.62, "Manual Initiation of Protective Actions," Rev. 1, June 2010.

- NRC RG 1.63, "Electric Penetration Assemblies in Containment Structures for Nuclear Power Plants," Rev. 3, February 1987.

- NRC RG 1.73, "Qualification Tests for Safety-Related Actuators in Nuclear Power Plants," Rev. 1, October 2013.

- NRC RG 1.75, "Criteria for Independence of Electrical Safety Systems," Rev. 3, February 2005.

- ~~NRC RG 1.81, "Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants," Rev. 1, January 1975.~~
  Delete

- NRC RG 1.89, "Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants," Rev. 1, June 1984.

- NRC RG 1.93, "Availability of Electric Power Sources," Rev. 1, March 2012.

- NRC RG 1.100, "Seismic Qualification of Electric and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," Rev. 3, September 2009.

- NRC RG 1.106, "Thermal Overload Protection for Electric Motors on Motor-Operated Valves," Rev. 2, February 2012.

- NRC RG 1.118, "Periodic Testing of Electric Power and Protection Systems," Rev. 3, April 1995.

Table 8.1-2 (1 of 8)

Criteria and Guidelines for Electric Power Systems

Criteria		DCD Section				Remarks
		8.2	8.3.1	8.3.2	8.4	
1. Appendix A to 10 CFR Part 50 – GDC		Requirements				
GDC 2	Design Bases for Protection Against Natural Phenomena	A	A	A		
GDC 4	Environmental and Dynamic Effects Design Bases	A	A	A		
GDC 5	Sharing of Structures, Systems, and Components	~~A~~	~~A~~	~~A~~		~~Not applicable~~
GDC 17	Electric Power Systems	~~add~~ A	A	A	A	
GDC 18	Inspection and Testing of Electric Power Systems	A	A	A	A	
GDC 33	Reactor Coolant Makeup	A	A	A		
GDC 34	Residual Heat Removal	A	A	A		
GDC 35	Emergency Core Cooling	A	A	A		
GDC 38	Containment Heat Removal	A	A	A		
GDC 41	Containment Atmosphere Cleanup	A	A	A		
GDC 44	Cooling Water	A	A	A		
GDC 50	Containment Design Basis		A	A		

RAI 177-8166 - Question 08.01-2

~~delete~~

Not applicable

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(A) Requirements and criteria provided in the subject document are applied to the noted section.

8.2 Offsite Power System

8.2.1 System Description

The offsite power system is the preferred source of power for the reactor protection system (RPS) and engineered safety features (ESF) during normal, abnormal, and accident conditions. It encompasses the transmission network, overhead or underground transmission lines, transmission line towers, switchyard components and control systems, switchyard battery systems, transmission tie lines, main generator (MG), generator circuit breaker (GCB), main transformer (MT), unit auxiliary transformers (UATs), standby auxiliary transformers (SATs), isolated phase bus (IPB), and the electrical components associated with them. The boundaries between the offsite power system and the onsite power system are the incoming circuit breakers of the switchgears, which are included in the onsite power system.

The switchyard is connected to the transmission lines to transmit the electricity produced by the APR1400 to the transmission network and to the transmission tie lines to provide offsite power to the auxiliary and service loads of the APR1400.

Electric power from the transmission network to the onsite electrical distribution system is supplied by two physically independent circuits. The COL applicant is to identify those independent circuits (COL 8.2(1)). The APR1400 is designed to meet the requirements in 10 CFR Part 50, Appendix A, and GDC 2, 4, ~~5,~~ 17, and 18 (References 1 through 5, respectively).

Delete

8.2.1.1 Transmission Network

The transmission network is not included in the scope of the APR1400 design. However, this subsection describes the transmission network in general terms. The transmission network is a source of reliable and stable power for the onsite power system. The transmission network design includes at least two preferred power supplies and each one has sufficient capacity and capability to supply power to the APR1400 safety-related and non-safety-related systems during all design modes.

Criterion 4 – Environmental and Dynamic Effects Design Bases

GDC 4 requires that SSCs associated with the offsite power system be appropriately protected against dynamic effects, including the effects of missiles that can result from equipment failures during normal operation, maintenance, testing, and postulated accidents.

The offsite power system is designed to provide power to systems important to safety during normal, abnormal, accident, and post-accident conditions. The offsite power system supplies electric power required for the operation of systems important to safety even if/when they are subject to adverse dynamic effects. The offsite power system is designed to meet the requirements of IEEE Std. 765.

Criterion 5 – Sharing of Structures, Systems, and Components

GDC 5 is related to the sharing of SSCs. There are no shared SSCs because the APR1400 design is a single-unit plant.

Add

Therefore, this GDC is not applicable to the APR1400.

Criterion 17 – Electric Power Systems

GDC 17 requires that offsite electric power be provided to facilitate the functioning of SSCs important to safety. The offsite power system has sufficient capacity and capability to permit functioning of SSCs important to safety. It also requires that two physically independent circuits from the offsite power system to the onsite power system be designed and located to minimize the likelihood of their simultaneous failure under operating, postulated accident, and postulated environmental conditions. The offsite power sources are fully independent from the onsite power sources and AAC power source. Conformance with this requirement is described in Subsection 8.2.1.3.

The COL applicant is to provide the results of grid stability analyses to demonstrate that the offsite power system does not degrade the normal and alternate preferred power sources to a level where the preferred power sources do not have the capacity or capability to support the onsite Class 1E electrical distribution system in performing its intended safety function. The stability analyses include the following contingencies (COL 8.2(6)):

a. APR1400 turbine-generator trip

d. Control

e. Instrumentation

If the trays are stacked, the order from top to bottom is as shown above.

Cables of each train run in separate raceways are physically separated from cables of the other trains. Separation of trains is in accordance with IEEE Std. 384, as endorsed by NRC RG 1.75. Raceways for non-Class 1E are separated from each Class 1E train A, B, C, and D in accordance with IEEE Std. 384. The raceway in the cable spreading area, main control room, and other congested areas is designed in accordance with IEEE Std. 384. The power and control wiring in control boards or panels is separated in accordance with IEEE Std. 420 (Reference 40).

Medium-voltage power cables are routed in an open-top ladder-type cable tray in a single layer with maintained spacing. The distance between adjacent cables within a tray is one-quarter the diameter of the larger cable. The cable tray fill criterion for low-voltage power cables does not exceed 30 percent of the cross-sectional area of the open-top ladder-type tray. The cable tray fill criterion for control cable does not exceed 50 percent of the cross-sectional area of the open-top ladder-type tray. Solid-bottom and solid-cover type cable trays are used for routing instrumentation cables, with an allowable fill of 50 percent of tray cross-sectional area. Cable splicing in a raceway is prohibited.

8.3.1.2 Analysis

The APR1400 Class 1E ac power system is designed to meet the requirements of GDCs 2, 4, ~~5,~~ 17, 18, 33, 34, 35, 38, 41, 44, 50, and the intent of NRC RGs 1.6, 1.9, 1.32, 1.47, 1.53, 1.63, 1.75, ~~1.81,~~ 1.106, 1.118, 1.153, 1.155, 1.160, and 1.204. The criteria and guidelines are shown in Table 8.1-2 and include their applicability in the electrical system design.

Delete

Delete

8.3.1.2.1 Conformance with General Design Criteria

Criterion 2 – Design Bases for Protection Against Natural Phenomena

GDC 2 requires that systems and components important to safety be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without the loss of their safety function capabilities.

The Class 1E onsite ac power system and its components are located in seismic Category I structures that provide protection from the effects of natural phenomena. Class 1E equipment is seismically qualified, and its mounting and installation are seismically designed to worst-case design basis earthquake for the site. Conformance with GDC 2 is addressed in Subsection 8.3.1.1.2.

Criterion 4 – Environmental and Dynamic Effects Design Bases

GDC 4 requires that systems and components important to safety be designed to accommodate the effects of, and be compatible with, the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents and be appropriately protected against dynamic effects, including the effects of missiles, that may result from equipment failures.

The Class 1E ac power system is designed to provide power to systems important to safety during normal, abnormal, accident, and post-accident conditions. The equipment and components of the Class 1E onsite ac power system are designed to meet IEEE Std. 323 for qualifying Class 1E application equipment in nuclear power plants. Class 1E electrical distribution equipment is located away from high- or moderate-energy lines and potential internal missile areas. Conformance with GDC 4 is addressed in Section 3.1.

Criterion 5 – Sharing of Structures, Systems, and Components

GDC 5 is related to the sharing of SSCs. There are no shared SSCs because the APR1400 design is a single-unit plant.

Add Therefore, this GDC is not applicable to the APR1400.

The inverters that provide reliable I&C power have sufficient capacity and capability to perform their intended function. The Class 1E 120 Vac I&C power system loads are listed in Table 8.3.2-3 and the inverter rating is shown in Table 8.3.2-4.

A 125 Vdc control center is provided for each of the 125 Vdc power system load groups. Each control center supplies power to its assigned bus and equipment and is powered directly from its associated 125 Vdc battery and battery chargers irrespective of the condition of other control centers. The Class 1E dc control center supplies power to one dc distribution panel and one static inverter.

8.3.2.1.2.7 Class 1E 125 Vdc Power System and 120 Vac Instrumentation and Control Power System Status Information

The parameters or status that are monitored in the MCR for the 125 Vdc power system and 120 Vac I&C power system are listed in Table 8.3.2-5.

Ammeters provided to monitor battery current have the capability to monitor both charge and discharge currents. Voltmeters are supplied to monitor dc and ac voltage of the buses and inverter distribution panels. The indications and alarms in the dc control center, battery charger control panel, and inverter distribution panel are listed in Table 8.3.2-5.

Ground fault detectors and their corresponding ground monitoring alarms are provided with sufficient sensitivity.

8.3.2.2 Analysis

The APR1400 Class 1E 125 Vdc power system is designed to meet the requirements of GDCs 2, 4, ~~5,~~ 17, 18, 33, 34, 35, 38, 41, 44, and 50 and the intent of NRC RGs 1.6, 1.32, 1.47, 1.53, 1.63, 1.75, ~~1.81,~~ 1.106, 1.118, 1.128, 1.129, 1.153, 1.155, 1.160, and 1.212. Table 8.1-2 includes their applicability of the GDC and NRC RGs to the electrical system design. Delete Delete

8.3.2.2.1 Conformance with General Design Criteria

Criterion 2 – Design Bases for Protection Against Natural Phenomena

GDC 2 requires that systems and components important to safety be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

The Class 1E 125 Vdc power system and its components are located in seismic Category I structures that provide protection from the effects of natural phenomena. Class 1E equipment is seismically qualified and the mounting and installations are seismically designed to the worst-case design basis earthquake for the site. Conformance with GDC 2 is addressed in Subsection 8.3.2.1.2.

Criterion 4 – Environmental and Dynamic Effect Design Bases

GDC 4 requires that systems and components important to safety be designed to accommodate the effects of, and be compatible with, the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents and be appropriately protected against dynamic effects, including the effects of missiles, that may result from equipment failures. The Class 1E 125 Vdc power system is designed to provide power to systems important to safety during normal, abnormal, accident, and post-accident conditions. The equipment and components of the Class 1E 125 Vdc power systems are designed to meet the IEEE Std. 323 for qualifying Class 1E application equipment in nuclear power plants. The Class 1E 125 Vdc electrical distribution equipment is located away from high- or moderate-energy lines and potential missile areas. Conformance with GDC 4 is described in Subsection 8.3.2.1.2.

Criterion 5 – Sharing of Structures, Systems and Components

GDC 5 is related to the sharing of SSCs. There are no shared SSCs because the APR 1400 design is a single-unit plant.

Add

Therefore, this GDC is not applicable to the APR1400.